TREASURY DEPARTMENT
UNITED STATES PUBLIC HEALTH SERVICE
HUGH S. CUMMING, SURGEON GENERAL

USPHS LIBRARY
DEC 3 1926
DETROIT, MICH.

SEWAGE DISPOSAL FOR SUBURBAN AND COUNTRY HOMES

SUPPLEMENT No. 58
TO THE
PUBLIC HEALTH REPORTS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

ADDITIONAL COPIES

OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT

10 CENTS PER COPY

SEWAGE DISPOSAL FOR SUBURBAN AND COUNTRY HOMES [1]

The Septic Tank and Sanitary Sewers

In suburban and rural districts the number of homes with modern plumbing is increasing rapidly each year. Although the house piping and fixtures add to the expense of a new home, many owners are willing to spend the extra money for the comfort and convenience of having hot and cold water spigots, kitchen sinks, bath tubs, and water closets.

No member of the family appreciates more than the mother the convenience of having hot and cold water in the house for cleaning, cooking, and all other domestic needs, and, at the same time, drains to take the waste water away. In addition to the advantages which have been mentioned, the entire family benefits by the added protection against such diseases as typhoid fever and dysentery, which are so often spread by flies and water. Although protection may be obtained by approved out-door sanitary privies which cost much less than plumbing systems and sewers, almost everyone will agree that the latter are much to be preferred and are well worth the extra cost.

In most cases there is no difficulty in deciding on the source of water supply and what equipment is needed so that the water may be piped into the house under pressure. The rural supply may be from a well or spring; and, in suburban sections, it may be through a connection with the city or town water works system. The kind of pump and storage tank required varies with local conditions. There are many firms which furnish equipment and are ready to advise as to practical arrangements. The State board of health will always gladly give advice.

The proper way of disposing of the liquid house wastes, in other words, the house sewage, without creating a nuisance and so that it will not be a menace to health, is often puzzling. Although much has been written concerning sanitary sewers and septic tanks, there are many people who have only a hazy idea of the subject or else a wrong impression as to what a septic tank really is.

WHAT HAPPENS IN THE SEPTIC TANK

First of all, it should be clearly understood that the septic tank does not purify sewage but merely gets the sewage ready for final dis-

[1] Reprinted, by permission, from the Health Bulletin, Vol. XVII, No. 6, June, 1925, issued by the Virginia State Department of Health.

posal in the soil or on filters. The purpose of the septice tank is to separate and hold the solid particles, which will settle to the bottom or float to the surface, in order that the liquid which reaches the outlet will be clear or nearly so. The sewage as it leaves the tank may, and usually does, contain almost as many bacteria as it does when it enters. Although it may be as clear as spring water, it is far from being pure and will cause bad odors if allowed to stand in an open ditch. Hence the septic tank is only the first step in the disposal process.

The deposit which collects in the bottom of the tank is spoken of as "sludge." The particles which float to the surface form a "scum" or "mat." Fortunately, most of the sludge and scum is changed into liquids and gases by a natural fermentation process which goes on continuously in a septic tank; otherwise, the tank would fill up with solid matter in a very short time. If the tank is large enough it may not require cleaning for several years. On the other hand, if the tank is too small not enough time is given for the fermenting bacteria to do their work and it will require cleaning often. A tank which is too small may clog up, for the reason that the solid particles are being forced right through to the outlet instead of being held in the tank as they should be. When this happens, the draintile lines will gradually begin to clog, and after a time may have to be taken up, cleaned, and relaid.

HOW LARGE SHOULD THE SEPTIC TANK BE?

How large the tank should be is a question which is often asked and is hard to answer. The more people there are in a home, the more sewage there will be, as a rule. However, one family of eight persons may use twice as much water as another family of the same size. Hence the tank for the first family should be larger. Experience seems to show that for average conditions the tank should be of a size to hold at least 50 gallons for each person. Tanks which will hold 60 or 70 gallons per person are even better.

The concrete and brick tanks described in this bulletin have a working capacity of 450 gallons, large enough for a family of eight or nine persons. For small houses with correspondingly small families, 400-gallon capacities may be provided; but it is not recommended that tanks of a smaller size than 400 gallons be installed. For a family of 15 persons the capacity should be about 700 gallons or more. The depth should be 4 feet below the sewage line and the length greater than the width.

WHAT SHOULD NEVER GO INTO A SEPTIC TANK

Rain water from the house roofs and gutters should never be allowed to go into the septic tank. The reason for this is that a

heavy rain may flood the tank and wash some of the sludge and scum through the outlet into the draintiling system. Also the ground around the draintile will become water-soaked and will not absorb the sewage readily. Likewise, cellar drains should never empty into the septic tank. Only standard toilet paper should be used. In no case should newspaper or other heavier paper, sticks, rags, rubbish, garbage, etc., be thrown into the toilets or sinks, as these will not decompose in the septic tank, but will remain either to stop up the pipes or to cause the tank to fill up with solid matter much more rapidly than it otherwise would.

FINAL DISPOSAL IN TOP SOIL—THE PURIFICATION FIELD

The most common method of taking care of the outflow from the tank is to let it soak into the top soil. The reason why the liquid must be spread out in the top soil is because this part of the soil contains thousands of bacteria which change organic matter into the kind of food necessary for the growth of plants, grass, and trees. By top soil is meant the top 20 or 24 inches. Below that depth there are very few of these bacteria. For example, the farmer would not expect to get much of a crop if he first scraped off 20 inches of the soil and then planted his corn, potatoes, or wheat. For the same reason the outflow from the septic tank, containing disease germs and foul smelling matters in liquid form, will not be purified unless acted upon by the bacteria in the top soil.

The length of draintile needed depends, first, on the nature of the soil and, second, on the daily amount of sewage to be cared for. A dry, sandy soil will take more sewage than a heavy soil such as clay. When the soil is clay it is best to dig deeper trenches for the draintile and partly fill them with cinders before laying the tile.

A given plot of land will absorb only so much sewage. When the sewage appears at the ground surface, or when the ground near the draintile lines becomes soft and soggy, in all probability too much sewage is going into that line. Hence it is necessary to spread the sewage over as large an area of land as possible, and this is done by means of a number of lines of open-joint draintile.

Often a single tile line is sufficient for the purification field. In this case the first four joints should be of glazed tile, bell-and-spigot joint firmly cemented. Where the plot of ground is not long enough it may be necessary to spread the sewage by means of a distributing box and several lines of open-joint tile drains running therefrom. The outlets from this box must be exactly at the same level in order that equal amounts of sewage may enter each line which is being used at the time. As will be explained further on, a stop-plank

may be placed in front of some of the outlets at times in order to let part of the purification field "rest."

No exact rule can be given as to the number of feet of draintile which should be put in, but the following suggestions will be helpful. Under the most favorable conditions, where there is a light, porous soil and the ground-water level is several feet beneath the surface, 30 feet of tile for each person may be enough. In tight soils which absorb sewage slowly, as much as 100 feet of tile per person may be needed. In every case locate the lines so that they may be made longer or more lines may be added in the future if necessary. The owner can soon tell whether the system is working all right by noting whether any sewage appears at the ground surface.

The first cuts and descriptions contained in this bulletin do not include an automatic siphon. The siphon has been left out in order to make the system as simple as possible. Although it is true that better distribution of the sewage can be obtained by means of a siphon, there are many small disposal plants which are working satisfactorily without siphons. If the number of persons served by the disposal plant exceeds 20, or the total capacity of sewage averages more than 500 gallons per day, a siphon should be installed. A table showing dimensions for various sizes and an illustration showing a septic tank with siphon are given at the end of this bulletin.

CONSULT LOCAL HEALTH OR SANITARY OFFICER

A number of the counties in many States now have full-time health officers. Others have sanitary officers. In these counties the prospective builder of a septic tank should always confer with the health or sanitary officer before starting construction. These officials can always give helpful suggestions as to location, size, etc. Their suggestions will usually result in a saving of money, and the officers will be glad to assist.

READY-MADE SEPTIC TANKS

Septic tanks of various designs made of metal, tile, or concrete are now advertised for sale. These are made up at the factory and shipped ready to be put into place. All of these tanks which meet the requirements of the State board of health should prove satisfactory for individual homes when properly installed and cared for. As a rule the greater the capacity of a septic tank, whether ready-made or home-made, for a given number of persons in the family, the less often will it need cleaning. For example, if there are five persons in the family, a tank which holds 300 gallons will require cleaning out

less often than a tank which holds only 200 gallons. Although the smaller one may not become clogged in such a way as to stop the flow of sewage, the chances are that it will become so filled with sludge and scum that it can no longer hold the solid particles contained in the sewage. Under such conditions the result will be that these particles will be forced right on through the tank and gradually clog up the purification tile. The owner should keep in mind that it is easier and cheaper to clean out a septic tank than to dig up, clean, and replace several hundred feet of draintile. A few dollars spent for a larger tank in the beginning will usually be a saving in the long run.

PURPOSE OF DISPOSAL PLANT

Unpurified sewage turned loose into a stream, sink hole, or on the surface of the ground in the vicinity of dwellings may be the means of causing typhoid fever or dysentery. Domestic sewage does not at all times contain disease germs, but no one can tell when it does or does not. Therefore it is the custom to regard all sewage as a menace to health unless disposed of in a sanitary manner.

There are several ways in which the sewage may cause sickness. It may get into the water supply used by the people for drinking purposes. If turned into a small stream running through a pasture in which there are milch cows, the milk supply may become contaminated. When cows stand in polluted water, some of the germs may get onto the udders and teats and then fall into the milk at the time of milking. Since germs multiply rapidly in milk, a few may contaminate a large quantity. If the sewer outlet is on a hillside or in an open ditch not far from the house, flies will be attracted to the deposits which form at and below the outlet. As every one knows, flies may carry disease germs to the kitchen and dining room. Hence such a sewer outlet near a dwelling is little or no better, and may be worse even, than having an open-back privy at the same place.

The discharge of sewage into a stream above the waterworks intake for a city, or town, or community, may be a serious menace to the public health, even though the water supply is filtered before it is used. The shorter the distance between the point where the sewage enters the stream and the water intake, the greater the danger.

In limestone regions there are many sink holes, and no one can tell which of these may connect with an underground cavern leading to a spring or well a long distance away. For this reason sewage should never be turned into a sink hole.

In addition to taking care not to pollute some other person's water supply the owner must not forget about his own spring or well. The sewer line from the house to the septic tank must have tight joints

so there will be no leakage. The plumber should be required to extend the cast-iron soil pipe to a point 5 feet outside the building line, and this is where the tile should begin, unless the well is located less than 50 feet of this point, in which case the cast-iron pipe should be extended until the cast-iron line is more than 50 feet from the well.

LOCATION OF SEPTIC TANK AND PURIFICATION FIELD

The location for the septic tank and the purification tile system must be selected with care. Although septic tanks as a rule do not cause complaints on account of bad odors, nevertheless the tank should be placed as far away from the house as practicable, but never closer than 50 feet to the well or spring. If the ground is level there is no way to tell the direction in which the underground water flows. Therefore, if the well does not have a tight casing for a depth of 50 feet or more, the farther away the tank and tile system are located from the well, the less will be the danger of polluting the water supply. On the other hand, if the ground has a gradual slope for a long distance, the chances are that the underground water flows in the same direction as the slope. Therefore, if the tank and tile system are located downhill from the well there should be very little danger of contaminating the water supply.

The descriptions and illustrations contained in this bulletin will be helpful to the home owner who prefers to build his own sewer line and disposal plant or employs a local builder to do the work.

In some localities brick tanks may be cheaper than concrete tanks. Therefore, two kinds of tanks, concrete and brick, are described.

Very often a person hesitates to build a concrete tank because he does not know how to go about making the wood forms. For this reason special attention is given to the amount of lumber and material needed, and how the forms should be built in sections and then put together and braced. The same set of forms may be used for the building of several tanks.

THE SEWER LINE FROM HOUSE TO SEPTIC TANK

The sewer line begins where the house plumbing system ends. The cast-iron soil pipe connecting with the house vent pipe should extend at least 5 feet outside the house building line. If there is a well within less than 50 feet of this point, the cast-iron tile should be extended farther, otherwise tile pipe may be used.

Tile sewer pipe is furnished in 2-foot lengths. It should be a vitrified clay pipe of good quality with bell-and-spigot ends. The 6-inch size is the more often used and is probably better than the 4-inch, because there is less danger of the 6-inch pipe becoming clogged with rags or sticks.

When the sewer line can not be laid straight all the way from the house to the tank, it should be laid as far as possible in a straight line and then a one-eighth or one-sixteenth bend put in. The next section should be laid straight as far as conditions will permit and another bend put in. The points where bends are made should be marked in some way so that the line can be easily found in the future should there be any trouble. If it is necessary to make a bend of more than 45° there should be a manhole.

LEAST FALL ALLOWABLE IN SEWER LINE

How much or how little fall shall be used in the sewer line from the house to the septic tank so that it will be self-cleaning is a question which is often asked. For a 4-inch sewer the fall or grade should be not less than 20 inches per 100 feet, which is 2 inches for each 10 feet in length. The fall for a 6-inch sewer may be one-half the above figures, namely, 10 inches per 100 feet, or 1 inch for each 10 feet of length. These are the safe minimum grades, although there are many sewers with grades less than the above which are giving very little trouble. Above the minimum limits the grade may be as much as conditions warrant.

The first thing to do after deciding on the location for the septic tank is to find out whether there is enough fall for the sewer line. If there is any doubt concerning this, it will be best to find out the difference in elevation between the points where the sewer will enter the tank and where it leaves the house. The best way to do this is by means of an engineer's level. However, it is not always convenient to get an engineer's level or obtain the services of a surveyor or engineer to measure the differences in elevation; therefore in the last part of the bulletin will be described a way in which this can be done with a carpenter's level and a simple support for same. The results should be near enough for the purpose in hand.

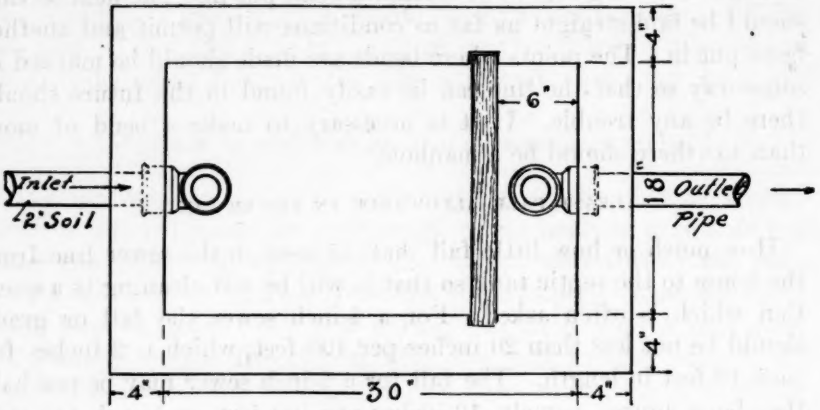
RUNNING TRAP SHOULD NOT BE USED

Several years ago it was the custom to put in the "sewer line" just outside the building, a "running trap," but only a few cities require this now. It is much better to allow any odors or gases to go up through the house vent pipe. There is no danger of these getting into the house if all the fixtures have traps.

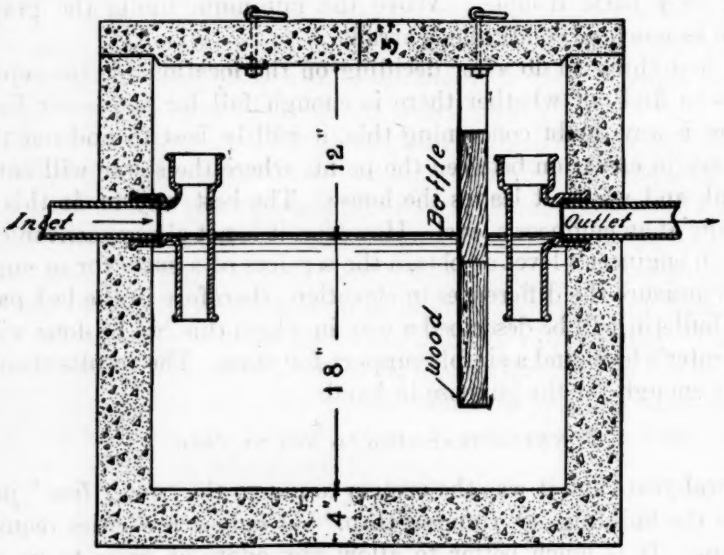
GREASE TRAP

Very often septic tanks give trouble or a sewer line clogs because of the gradual collecting of greases. Most of this grease comes from the kitchen. For these reasons there should be a grease trap on the kitchen line, but there should be no water-closet connected with this line. Every few months the trap should be inspected and the grease

skimmed off. From time to time the sediment in the bottom, consisting mostly of coffee grounds, should be removed.



Plan



Section

Grease Trap

PLATE -A-

SIMPLE METHOD OF SECURING GRADE FOR HOUSE SEWER

Assume that the location for septic tank and the line of house sewer has been decided upon and may be illustrated as shown in Plate B. From the house (point A) the ground is nearly level for 50 feet

to point B, and from there on through points C and D to point E there is plenty of fall. As the first 50 feet of the ground is nearly flat, it is assumed that the 6-inch line will be used. Therefore, the minimum grade should be 5 inches for the 50 feet to point B, or 1 inch in each 10 feet. As there is plenty of fall from B to septic tank at E, the remainder of the line should be laid on an even grade to strike point D at a depth of about 1 foot 8 inches below the surface of the ground and continue to point E at the same depth.

To mark out the right grades the following materials are necessary—

Stakes 4 feet to hold cross pieces.
Strips 3 feet long for cross pieces.
Stakes 3 feet long to drive in line of trench.
Straightedge 10½ feet long with piece 1 inch nailed on under side at one end as shown in Figure 3.
Carpenter's level and chalk line or cord.

To begin, drive two stakes at A and nail on cross piece as shown in Figure 4. The top of cross piece should be 5 feet above the level of the bottom of the cast-iron sewer where it leaves the house. Next set one of the three-foot stakes 10 feet out from point A on a line with the trench. Drive this stake down until when the straightedge is placed with one end on top of cross piece and the other end with the inch block on top of the stake, the top of the straightedge is level. The top of the stake will then be 1 inch lower than top of the cross piece. Set three more stakes in line 10 feet apart in the same manner. Set two of the 4-foot stakes for cross piece at point B the same as at point A. The level of the cross piece at point B is found by using the straightedge from the fourth stake in line as described for the others. As the fall from B to C, D, and E is more than enough, it will be necessary only to drive two stakes at D and two at E and nail on cross piece 3 feet 4 inches above the surface of the ground at each point. Two more 4-foot stakes for cross pieces should be driven at point C, about halfway between B and D. The level for this cross piece is found by sighting from top of cross piece at D back to top of cross piece at B and raising or lowering the middle cross piece at point C until it is on the line of sight. Drive a nail in the middle of the top of each of the cross pieces and stretch a chalk line from A to B, C, D, and E. The trench may now be dug on an even grade by measuring down from the chalk line with a strip 5 feet long.

The above methods can be used for trenches of any length. The bottom of the trench should be smooth and changes in grade should not be made any oftener than necessary.

LAYING THE SEWER PIPE FROM HOUSE TO TANK

The laying of the pipe should begin at the septic tank or outlet, with bell ends facing up hill. It is best to scoop out the earth from

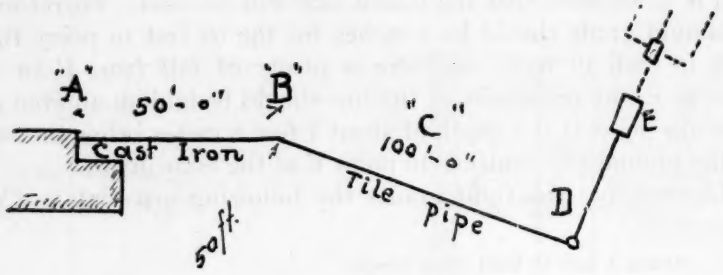


Fig. 1

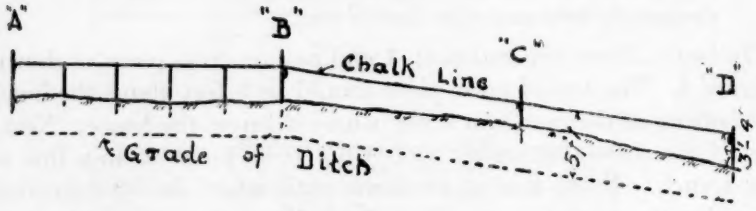


Fig. 2

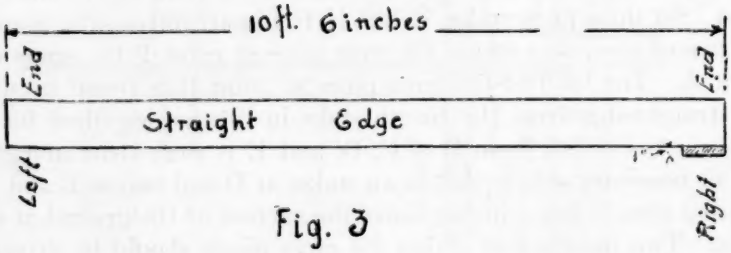


Fig. 3

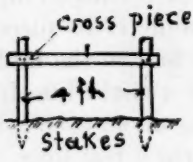


Fig. 4

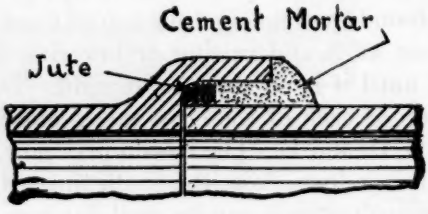


Fig. 5

PLATE - B -

under the bells so that the barrel of the pipe for its entire length will rest on bottom of trench. This is not always done, but it is the best practice. The materials needed for making joints are as follows:

(1) About ½ gallon of cement grout—that is, Portland cement mixed with water thin enough to pour.
(2) Portland cement mortar of 1 part cement and 1 part sand.
(3) Hemp or jute.
(4) Wooden calking tools, trowel, and mittens.
(5) A swab or "follower" for cleaning out the inside of pipe after the joints have been made.

After the pipe length is placed in position, dip a twisted piece of hemp or jute (of a length to go around the pipe) in the cement grout and then ram into the joint. This gasket will center the pipe and also will keep the mortar from squeezing through into the inside of the pipe. Then fill joint with mortar, carefully working it in all around with the hands and the caulking tools. Use enough mortar so that the joint may be beveled off. Then swab out the inside, to remove any mortar which may have been squeezed through. (See fig. 5, Plate B.)

After the joint is made it is well to wrap it with a piece of cheesecloth, tied at the top, so as to hold the mortar in place. Otherwise, the mortar, before it sets, may sag or fall away from the joint. This method also makes it possible to use a more moist mortar and get smoother joints. There will also be less danger of knocking the mortar off when earth is carefully tamped under and around it soon after the joint is made.

TREE ROOTS CLOG SEWERS

Roots of trees often cause considerable trouble, especially if the joints are not tight. In seeking for moisture a root will find its way through a very small opening, and after it once gets in it will grow rapidly, filling up a section of the sewer and also forcing the mortar out of its joints. If the sewer line can not be laid far enough away from trees and shrubs so that roots can not reach it, more than usual care should be taken to see that the joints are well made and that plenty of mortar is used. In such a situation it is best to use cast-iron pipe with leaded joints. While this costs more in the beginning, it usually proves a saving in the end.

Description of a Simple System

Plate C shows a common arrangement for a sewer system and disposal plant. It will be noticed that the house vent pipe is on the outside. It is often so placed when plumbing is put in some time

after the house is built. Note that the grease trap is on the kitchen drain only, which is then connected with the sewer line. No sewage from water closet should go into the kitchen drain and grease trap.

The sewer line is more than 50 feet away from the well. Therefore bell-and-spigot tile pipe with cement joints may be used instead of cast-iron soil pipe. The ground between the house and the septic tank being nearly level, the sewer must be laid with as little fall as possible. Therefore a 6-inch sewer piper is used and fall is made 1 inch per 10 feet. After having decided on the location for the septic tank, set the grade stakes as shown in Plate B and then dig the trench. The laying of the sewer pipe should be upgrade from the septic tank to the house.

A concrete septic tank is shown; but it may be made of hard brick, as will be described later.

The sewer line from the septic tank to the distributing box should be 4-inch bell-and-spigot pipe with cement joints. The fall may be as little as one-half inch per 10 feet. The bottom of this pipe where it enters the distributing box should be about 2 inches higher than the floor.

The outlet pipes from the distributing box shall be set on the floor and all at the same level. It is best to make the concrete floor first, set the outlet pipes, and then make the forms for the walls and cover. Note that bell-and-spigot pipes with cement joints are used as far as the bends. The fall as far as the bends should be not less than one-half inch per 12 feet and as much greater as may be necessary. The purpose of these lines is to carry equal quantities of sewage to the several lines or draintile.

The picture shows how the lines of tile are laid at right angles to the slope of the ground. These lines must have an even fall of one-half inch per 12 feet for their entire lengths. If the fall is greater, the sewage will rush to the far ends instead of some seeping out of all the joints. Note that the lines may be made longer in the future if more tiling is needed.

Concrete Septic Tanks

The concrete septic tank shown in Plate D has a working capacity of 450 gallons, and is designed to serve an average family of eight persons or less.

To build the tank of concrete it is first necessary to dig the hole of sufficient size and depth and then provide forms for holding the concrete until it becomes thoroughly set. Where the soil is tight and firm, it is possible to dig the hole the exact size of the outside dimensions of the tank and allow the earth sides of the hole to serve as the outside form for the concrete. It is necessary then to use only

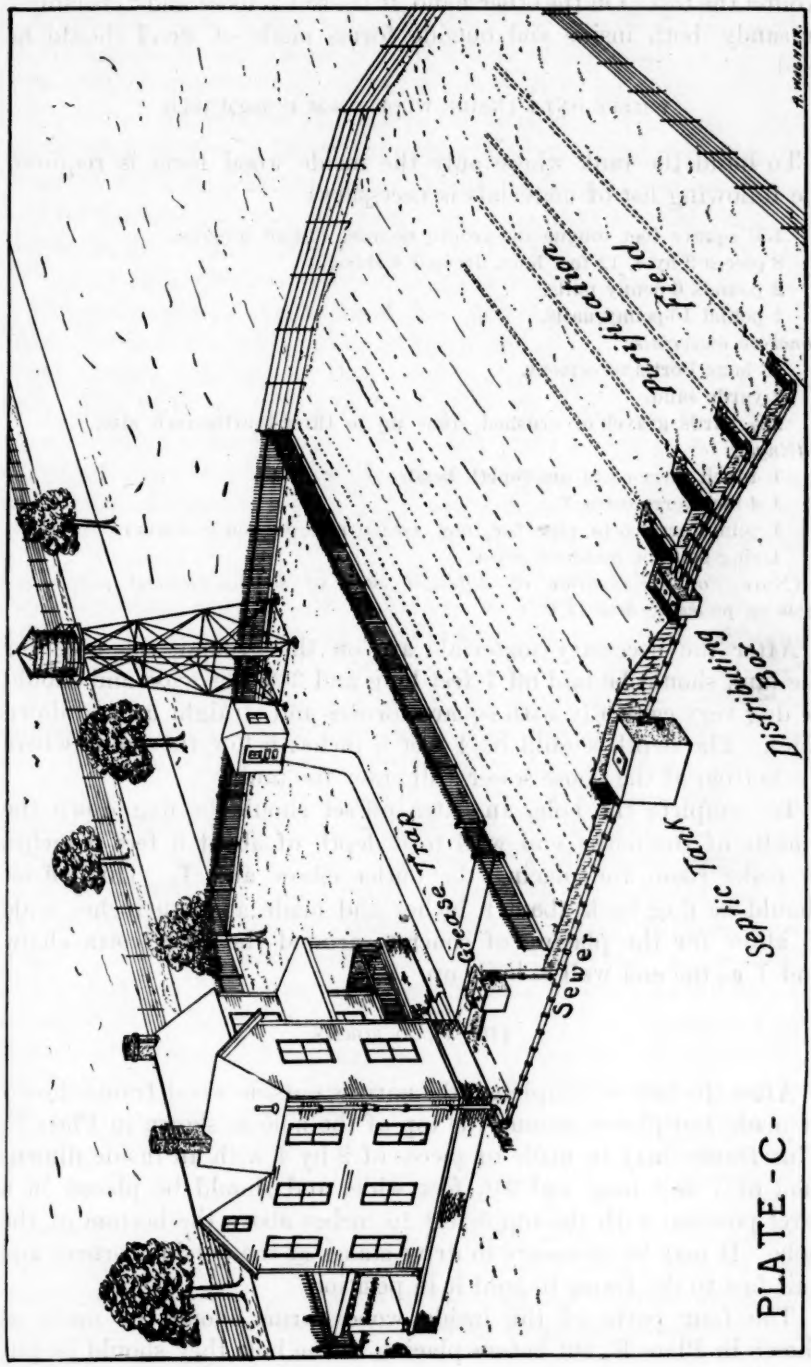

Grease Trap
Sewer
Septic Tank
Distributing Box
Absorption Field
A. HAGNER.

PLATE - C -

one wood form for the inside, with just a narrow outside wood frame around the top. On the other hand, if the soil is loose and "crumbly" or sandy, both inside and outside forms made of wood should be used.

WHERE ONLY INSIDE WOOD FORM IS REQUIRED

To build the tank where only the inside wood form is required the following list of materials is necessary:

150 square feet tongue-and-groove boards, 12-foot lengths.
8 pieces 2 by 4, 12 feet long, dressed 4 sides.
2 pounds 6-penny nails.
1 pound 10-penny nails.

Concrete materials:

16 bags Portland cement.
2 yards sand.
2½ yards gravel or crushed stone up to three-fourths-inch size.

Fittings:

1 4-inch terra-cotta one-fourth bend.
1 4-inch terra-cotta T.
1 joint terra-cotta pipe for inlet (same size as house sewer).
1 ring bolt for manhole cover.

(NOTE. *For specification of different sizes of sewage-disposal plants see table on pages 40 and 41.*)

After the necessary materials are on the ground, the hole for the tank should be laid off 7 feet long and 3½ feet wide and should be dug very carefully with square corners and straight up and down sides. The depth should be 4 feet 6 inches below the point where the bottom of the house sewer will enter the tank.

To complete the hole, an extra off-set should be dug down the middle of the outlet end wall to a depth of about 3 feet 6 inches to make room for placing the outlet elbow and T. This off-set should be dug back about 9 inches and made about 9 inches wide to allow for the placing of concrete around the terra cotta elbow and T as the end wall is built up.

THE WOOD FORMS

After the hole is completed, the narrow outside wood frame should be made and placed around the top of the hole as shown in Plate F. This frame may be made of pieces of 2 by 4 with an inside dimension of 7 feet long and 3½ feet wide, and should be placed in a level position with the top 5 feet 10 inches above the bottom of the hole. It may be necessary to drive stakes at the outside corners and nail fast to the frame to hold it in position.

The four parts of the inside wood forms should be made as shown in Plate E, but before placing in the hole they should be put together on the ground, using only about six 6 d. nails at each corner.

These nails should be set back so that the corners may then be sawed off on a bevel, as shown in Plate E.

Two 2 by 3 inch strips, each 2 feet 6 inches long, should be attached to the inside form 9 inches from the ends of the form, as shown in Plates E, F, and G. These strips are to provide grooves for holding the concrete baffle when it is placed in position. The strips should be beveled on the sides so that they may be separated from the concrete without difficulty when the inside form is removed.

Next the two 2 by 4 cross pieces should be placed across the top of the form and nailed securely with 10 d. nails to the outside edges of the upright pieces on each side, as shown in Plate F.

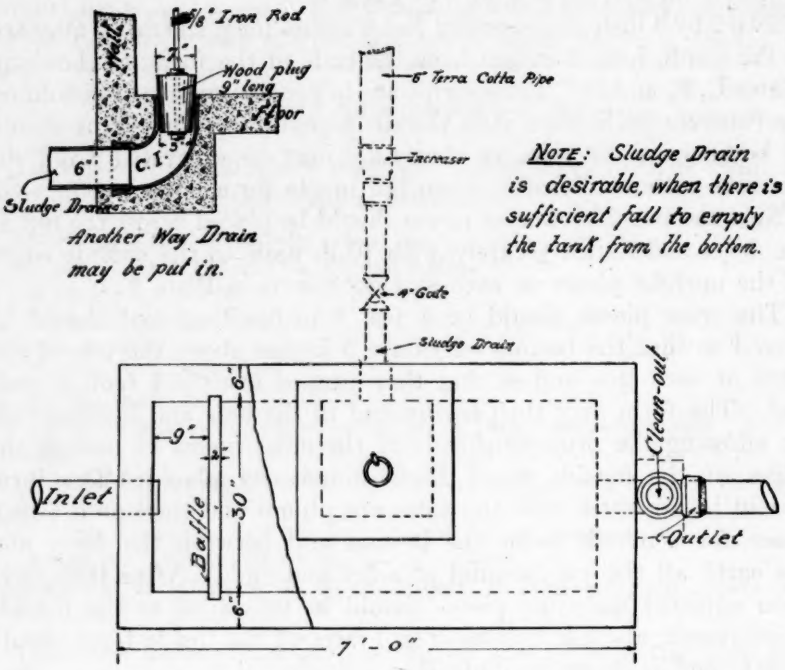
The cross pieces should be 4 feet 6 inches long and should be placed so that the bottom edges are 5 inches above the top of the form at each side and so that they project exactly 1 foot at each end. The form may then be lowered in the hole and is supported by allowing the projecting ends of the cross pieces to rest on the edges of the outside wood frame previously placed. The form should be adjusted until the sides are plumb and there is a 6-inch space for concrete under the bottom and between the form and the earth all the way around at sides and ends. After they have been adjusted the cross pieces should be toe-nailed to the outside wood frame; also the bottom cross braces of the inside form should be attached as shown in Plate E.

The above description applies to the tank design as pictured in Plate D. Such design does not require any T joints for intake or outlet, with the consequent necessity for cast-iron pipe with leaded joints. It does call for one terra cotta elbow, but this is set in concrete outside the tank and is not likely to break off.

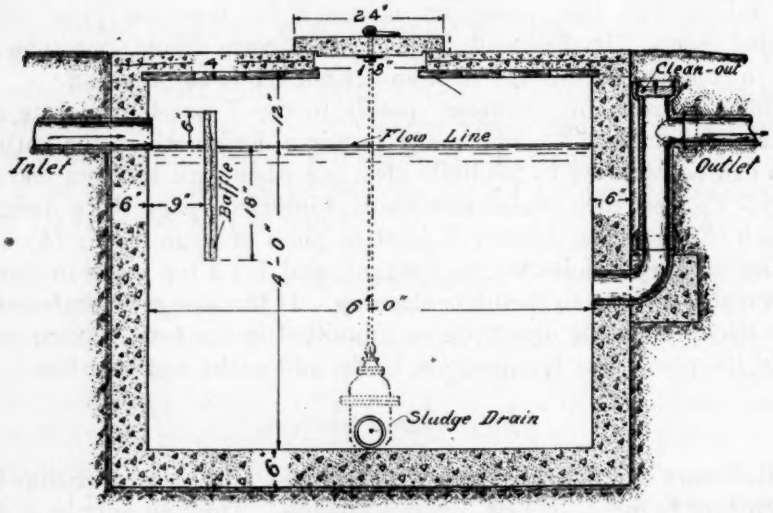
Some constructors, however, prefer to use T or elbow joints in place of a scum baffle; and many prefer a design where the entire top can be removed to facilitate cleaning when such becomes necessary. To meet such preferences there is inserted (page 18) a design which shows (*a*) a sanitary T-joint in place of scum baffle; (*b*) an outlet sanitary T-joint within the tank, and (*c*) a top made in three removable sections to facilitate cleaning. If this design is preferred, one may follow the directions as submitted in the text, leaving out only the provisions for manhole, baffle, and outlet construction.

THE CONCRETE MIXTURE

To secure a practically water-tight septic tank it is particularly important to make the best concrete possible. This can only be done by accurately measuring and proportioning the cement, sand, and gravel and by mixing carefully according to approved methods. It



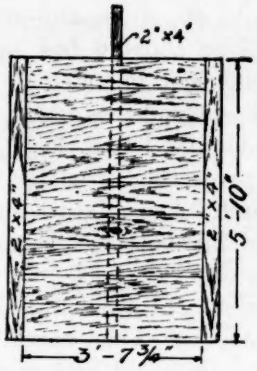
Top View



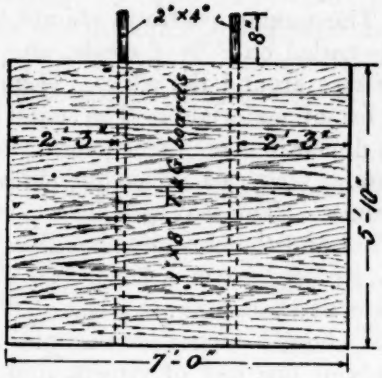
Concrete Septic Tank

A. WAGNER

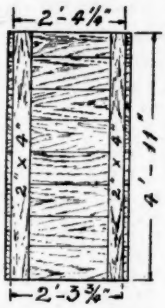
PLATE-D-



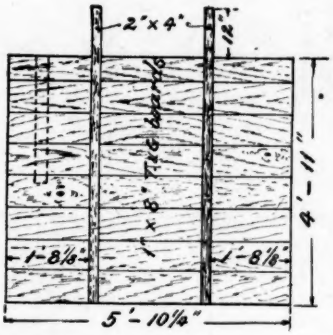
Outside End Form
make 2.



Outside Side Form
make 2.

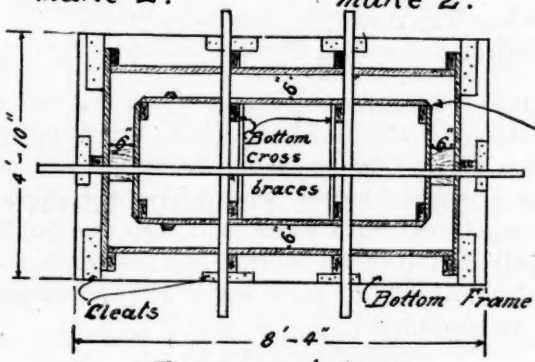


Inside End Form
make 2.



Inside Side Form
make 2.

Detail of Box
For Inlet & Outlet



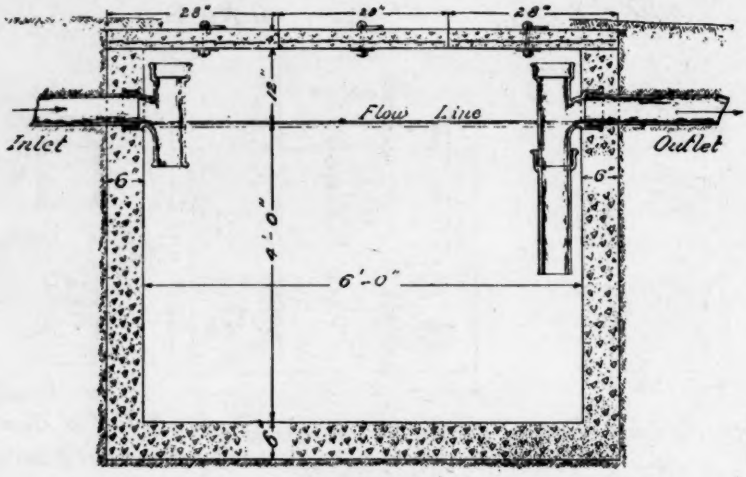
Forms put together

Detail of Corner

A. WAGNER.

PLATE -E-

is necessary, therefore, to have a mixing platform and a measuring box. The mixing platform should be made of tongue-and-groove boards nailed on 2 by 4 cleats, and should be about 6 feet square with strips around the edges. (Lumber sufficient included in previous list of materials.) The measuring box should be made with inside dimensions of 2 feet long, 1 foot wide, and 1 foot deep, with substantial strips nailed on the sides and projecting from the ends for handles. This box will hold 2 cubic feet. The mixture should be 1:2:4 and the concrete should be mixed in "batches" requiring one bag of cement at a time. To prepare each "batch" of mixed concrete, first measure out a box of sand and spread it out to a thickness of about 2 inches on the mixing platform. Then spread the contents of one bag of cement evenly over the sand and mix the



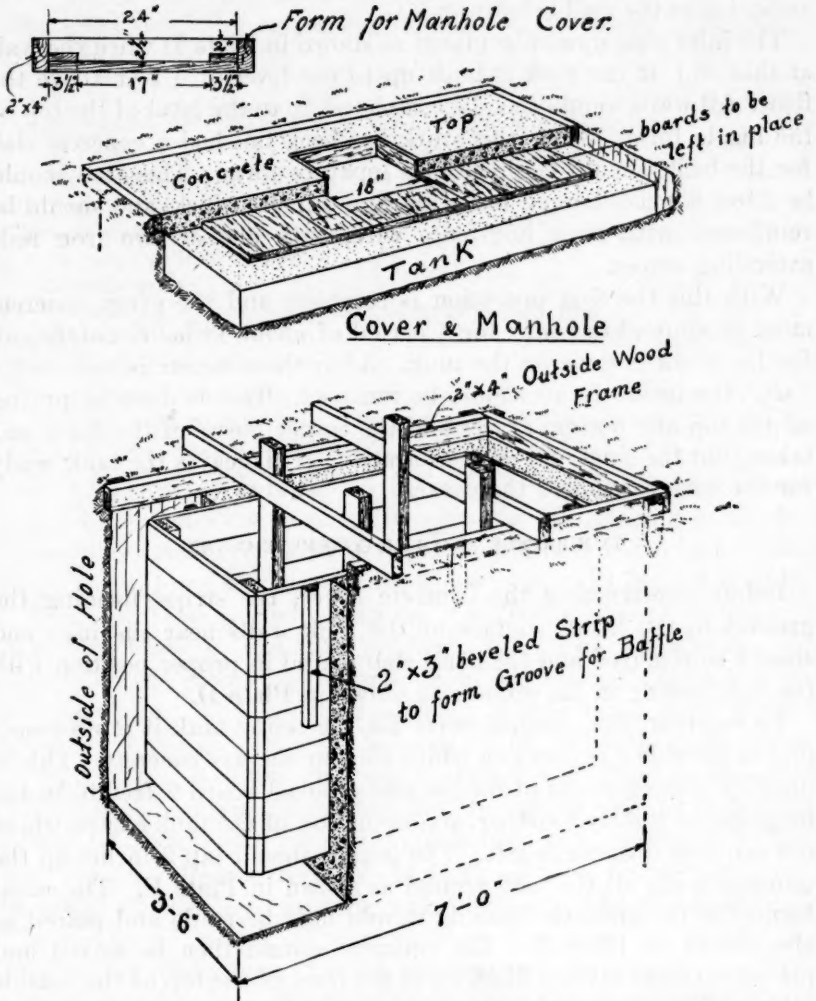
Concrete Septic Tank with a Sanitary T Instead of Baffle, and with a Removable Top

two together "dry" until a uniform color shows that the two are thoroughly mixed. Next add water slowly and mix until a uniform mortar is secured, which should then be spread out on the platform to a thickness of about 2 inches. Before being added, the stone or gravel should be thoroughly wet with water, and then two boxfuls should be emptied evenly on top of the mortar and the whole mass thoroughly turned and mixed, adding more water as required until a good "quaky" mixture is secured.

POURING THE CONCRETE BOTTOM AND SIDE WALLS

The first two "batches" of mixed concrete should be lowered in a bucket or "coal scuttle" and emptied in a pile down through the middle of the bottom. As each "batch" is emptied, the concrete

should be tamped until the water comes to the top and the mass spreads out to a 6-inch thickness through the middle portion of the bottom and tapers off toward the sides and ends. The third "batch" should be poured outside the form and tamped until sufficient con-



Inside Form, No Outside Form required.

PLATE-F-

A. HAGNER.

crete runs under and joins that previously poured, forming a uniform 6-inch thickness for the bottom of the tank. The remaining "batches" necessary should be poured evenly around the outside of the form and thoroughly spaded as poured.

When the wall at the outlet end of the tank is filled up 2 feet above the floor the 4-inch terra-cotta elbow of the outlet pipe should be placed in position as shown in Plate D. After some concrete has been tamped around this elbow to hold it in position, the 4-inch terra-cotta T should also be set as shown in Plate D and concrete filled around it as the wall is built up.

The inlet pipe should be placed as shown in Plate D when the wall at that end of the tank is built up to the level of 4 feet above the floor. All walls should then be completed up to the level of the top of the inside form. After this work has been finished a concrete slab for the baffle should be made in a separate form. This slab should be 2 feet 8 inches long, 2 feet wide, and 2 inches thick, and should be reinforced with some hog-fence wire, with one or two iron rods extending across.

With this the first operation is complete and the green concrete must be allowed to "set" for a period of about 48 hours before any further work is done on the tank. After the concrete is sufficiently "set," the inside forms should be removed. This is done by prying off the top and bottom braces and the corner pieces of the form and taking out the sides and ends separately. This leaves the tank ready for the construction of the cover.

THE BAFFLE AND THE CONCRETE COVER

Before constructing the concrete cover, the strips forming the grooves in the inside surface of the tank walls near the inlet end should be removed and the baffle slab placed in proper position with the ends resting in the grooves as shown in Plate D.

To construct the concrete cover for the septic tank it is necessary first to provide a support on which to pour the wet concrete. This is done by placing pieces of tongue and grooved board 2 feet 10 inches long, joined tightly together, across the top of the tank except where the manhole opening is left. The boards should lap 2 inches on the concrete walls all the way around as shown in Plate F. The wood forms for the manhole opening should next be made and placed as also shown in Plate F. The concrete should then be mixed and placed until the form is filled up to the level of the top of the outside frame. The concrete for the cover should be very carefully mixed, avoiding the use of any gravel or stone above one-half inch in size. It should also be thoroughly tamped or "puddled" as it is poured and the top smoothed off with a trowel or "float." After the top is finished it should be covered over with an old piece of canvas, tar paper, or a number of boards to protect it from sunshine or rain until the concrete is thoroughly "set." After about 48 hours the covering and remaining forms may be removed. The manhole cover should be made of sand and cement mortar in a separate form with

a hand-hold ring inserted in the middle as shown in Plate F. It should also be reinforced with some hog wire and short iron rods.

WHERE BOTH INSIDE AND OUTSIDE WOOD FORMS ARE USED

To build tank in loose or sandy soils where both inside and outside wood forms are necessary the following list of materials will be required:

Lumber:

300 square feet tongue and grooved boards, 12-foot lengths.
14 pieces of 2 by 4, 12 feet long, dressed four sides.
4 pounds of 6 d. nails.
1 pound of 10 d. nails.

Concrete materials:

15 bags Portland cement.
2 yards sand.
2½ yards gravel or crushed stone, up to ¾-inch size.

Fittings:

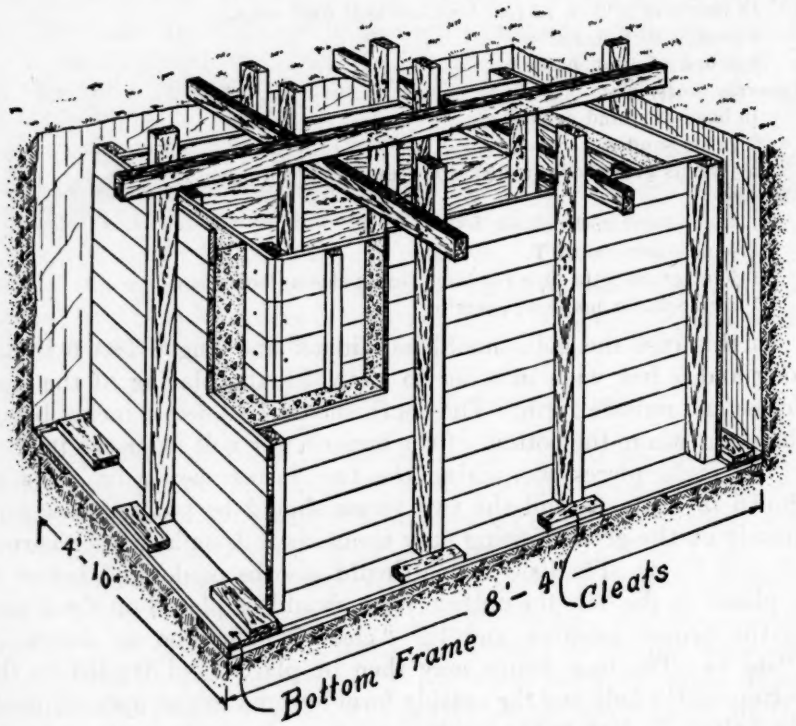
1 4-inch terra-cotta elbow.
1 4-inch terra-cotta T.
1 joint terra cotta pipe for inlet (same size as house sewer).
1 ring bolt for manhole covering.

In this case the hole should be laid off and dug 8 feet 6 inches long and 5 feet wide in order to allow for the placing of the base frame and outside form. The depth should be 4 feet 6 inches below the point where the bottom of the house sewer will enter the tank.

The eight pieces comprising the two forms should be made as shown in Plate E, and the two forms should be put together separately on the ground, using only about six 6 d. nails at each corner of each form. The base frame should also be made, and before it is placed in the hole the outside form should be placed on the frame in the proper position and the "cleats" nailed on as shown in Plate G. The base frame may then be placed and leveled in the bottom of the hole and the outside form lowered to rest upon it inside the "cleats." Before the inside is set in position, the corners should be sawed off on a bevel and the cross pieces attached as described for "inside form" alone. The remaining operations of setting and bracing the inside form, mixing and pouring the concrete, construction of the cover and placing of the fittings, are identically the same as previously described, except that wood boxes as shown in Plate E should be made and placed between the walls of the forms at the ends to provide openings in which the inlet and outlet pipes may be placed at the levels as shown in Plate D. These pipes should not be placed until after both the inside and outside wood forms are removed. After the forms have been removed, the pipes should be firmly cemented in, and at the outlet end the concrete should project to inclose completely the terra cotta elbow as shown in Plate D.

CLEAN-OUT DRAIN FOR SEPTIC TANK

As has been previously explained, when a septic tank works properly a certain portion of the sewage is retained in the tank as "sludge" and "scum." These solids accumulate gradually until a point is reached where the tank must be cleaned out. Where there is sufficient slope of the ground away from the place where the septic tank is built, it is advisable to install a clean-out drain pipe from the bottom of the tank leading to a shallow pit in the ground where



Showing both Inside & Outside Forms in Place

PLATE -G-

the contents of the tank may be drawn off when necessary without having to handle the material.

The best arrangement for a clean-out drain consists of a short piece of 4-inch cast-iron pipe placed through the side wall of the tank near the bottom with a 4-inch gate valve connected to it just outside. The gate valve should have a valve stem long enough to reach to the surface of the ground and this should be inclosed in a valve box made of concrete, brick, or two joints of 6-inch terra cotta pipe. On the outside end of the gate valve should be attached an-

other short piece of 4-inch cast-iron pipe and then a terra cotta 4-inch to 6-inch increaser to connect with a 6-inch terra cotta pipe for the remainder of the sludge drain. The materials required for this arrangement are—

1 4-inch gate valve.
1 5-foot length of 4-inch cast-iron soil pipe (to be cut in 2 pieces).
1 terra cotta increaser 4 to 6 inches.
1 4-foot valve stem.
8 pounds pig lead.
1 pound jute.

Another cheaper arrangement shown in upper left-hand corner of Plate D consists of a 6-inch cast-iron short sweep connected to a short length of 6-inch cast-iron pipe set in the bottom of the tank with the pipe extending away from one side. A wood plug attached to a ⅝-inch iron rod is used to stop the opening. This arrangement will require—

One 6-inch cast-iron short sweep.
One short piece of 6-inch cast-iron soil pipe.
One ⅝-inch iron rod, 5½ feet long (wood plug to be attached as shown).
Six pounds pig lead.
One-half pound jute.

In either case the cast-iron parts for clean-out drains should be put together with jute and lead before they are fastened in the wall or bottom of the tank.

Either the "gate valve" or "plug" arrangement may be installed with any concrete or brick septic tank.

If the gate valve clean-out is to be used with any septic tank, provision should be made for leaving a hole for the pipe through the side wall of the tank in the right position. If the plug arrangement is used, the cast-iron short sweep and pipe should be placed in position before the concrete bottom for the tank is poured.

The Purification Field

The purification system following the septic tank usually consists of a 4-inch terra-cotta "feed line" from the septic tank to a "distributing box," with a number of short "distributing lines," and of 4-inch terra-cotta pipe connecting with an equal number of "drain-tile lines." The drain lines are made of 4-inch farm tile and are laid open joint in parallel lines or otherwise. Sometimes the purification system may consist of a single line of pipe leading directly from the septic tank, in which case the first four or five lengths should be 4-inch bell-and-spigot pipe with cement joints and the remainder 4-inch farm tile laid open joint. In either arrangement the terra-cotta pipe line, or lines, with cement joints merely con-

veys the sewage to the open-joint drain-tile lines, and should have a fall of one-half inch in 12 feet or as much more as may be necessary. The one or more open-joint draintile lines should have as near an even fall of 4 inches to the 100 feet or practically one-half inch in 12 feet as it is possible to lay them.

Where several lines of draintile are used, unless there is an arrangement for distributing the flow of the sewage as near equally as possible to the various lines, the purification system will not be satisfactory. The old method was to use Y and T branches set in the main feed line and leading into the various lateral lines, but this has not proved generally satisfactory. The best arrangement is a distributing box. Plate H shows two types made of concrete.

Distributing boxes may be made of either concrete or brick, with one inlet pipe and as many outlet pipes as desired. The important point is to see that the outlet pipes are all placed at exactly the same level.

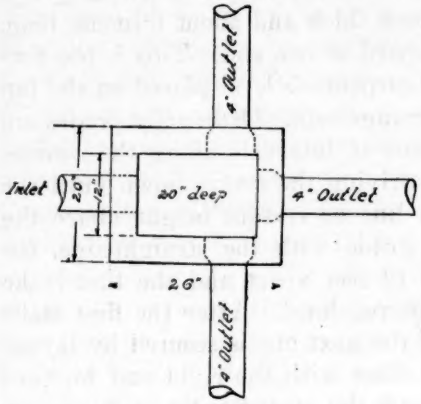
AMOUNTS OF DRAINTILE NECESSARY

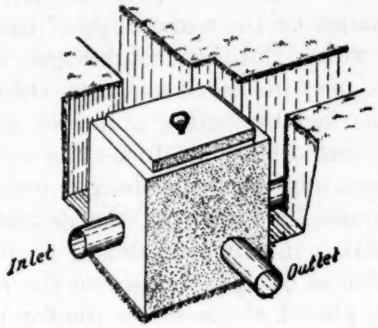
As has been previously stated, there are no set rules for fixing the amount of draintile. The number of feet which should be installed with any particular septic tank is determined entirely by the character of the soil in which the tile is laid and by the approximate average daily amount of waste water discharged from the home into the septic tank. The average family of five persons uses about 25 gallons of water per person or a total or 125 gallons per day. Larger families will use more; also some families use more per person than others. In any event the most of the water used goes to the septic tank as wastes from bath tub, toilet, lavatory, and kitchen sink, and from the tank it must be disposed of in the soil by the draintile system. The object of the draintile is to spread the liquid sewage out through enough ground so that there will be sufficient soil in contact with the tile to absorb without difficulty all the waste water as it seeps from the open joints between the pipes.

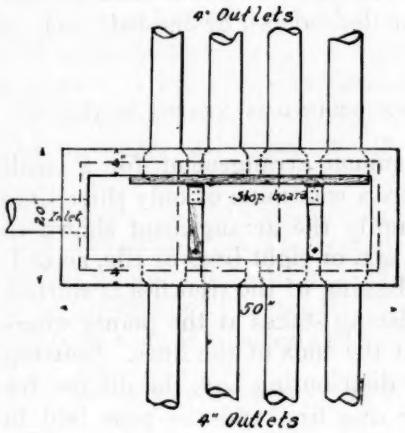
In dry, sandy, or open porous soils, 30 feet of drain tile per person for the average family may give good results. In more compact but still porous soils, 50 feet per person will be required, and in some of the tight clay soils as much as 100 feet per person may be needed. In every case except where the natural soil is very dry, open, and porous, the draintile pipes should be surrounded with cinders, gravel, or other porous material placed in the trenches where the tile is laid. In every case the owner must use his judgment and should arrange the draintile system so that the drain lines may be extended or more lines added if necessary.

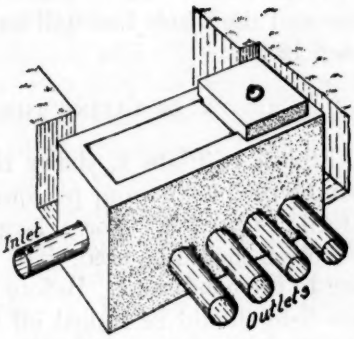
STRAIGHT EDGE FOR SECURING RIGHT GRADE FOR DRAINTILE

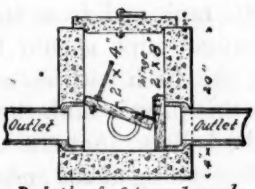
Since the success of the whole disposal plant will depend a great deal on the accuracy with which the draintile lines are laid, it is very important to secure the right grade. Where an engineer's or











Detail of Stop board

PLATE-H- Two types of Distributing Boxes.

The bottom of inlet pipe should be 2 inches above the floor. The outlets must be set on the floor, all at same level, so that equal amounts of sewage will go to the several lines. The "stop board" shown in detail is for cutting out of service half of the lines for several months so that part of the drainage field may rest

architect's level is available with some one to use it, the matter is simple; but in the absence of such aid it is necessary to make use of things commonly on hand. A straightedge to be used with a carpenter's level has been previously described, and it is recommended that a similar arrangement be used for determining grades for draintile. This should be made of a straight board 12½ feet long with a little strip one-half inch thick and about 6 inches long, nailed on the under edge of the board at one end. This is the forward end of the straightedge. A carpenter's level placed on the top edge of the board completes the arrangement. Ordinarily grades are marked by setting a line of stakes at intervals along the courses where ditches are to be dug and driving the stakes down until the tops represent the desired grade line or certain height above the grade line. To get the desired grade with the straightedge, the stakes in any line should be set 12 feet apart and the first stake should be driven down to the required level. After the first stake is placed, the level for the top of the next one is secured by laying the straightedge from one to the other with the right end forward and driving the second down until the straightedge will rest on the two with the top level. The level for the top of the third stake is found by using the second for a guide in the same manner, and so on down the line until all the stakes are set. Placed in this manner the top of each stake in line will be one-half inch lower than the last one and the whole line will have the desired fall of one-half inch in each 12 feet.

METHOD OF LAYING TILE WHEN GROUND IS NEARLY FLAT

Figure 1, Plate I, shows the common arrangement for a small family of three or four persons where a maximum of only three lines of tile is needed. For a larger family the arrangement shown in Figure 2 should be used, with four, six, or eight lines of tile, according to the conditions. Before the digging of the trenches is started, the field should be staked off by placing stakes at the points where the draintile lines will begin and at the ends of the lines. Starting from the septic tank and from the distributing box, the ditches for the bell-and-spigot pipe should be dug first and the pipe laid in the bottom of the ditch with an even fall of one-half inch in 12 feet or more. As this pipe is laid, the earth should be scooped out from underneath the bells so that the barrels of the pipe will rest on the firm earth. Beginning at the ends of the terra-cotta lines, the ditches for draintiles should be dug about 4 inches deeper than the tile will be laid. In flat ground the grades for the bottom of these ditches can usually be gauged by the eye. After the ditches have been dug, a line of stakes should be set 12 feet apart in the bottom of the

ditches. These stakes should be made of short pieces of 1 by 3, about 1 foot long and sharpened at one end. They should be driven in line just to one side of the center line down through the bottom of the ditch and with their flat surface in line with the ditch. To get the right grade the first stake should be set near the end of the terra-cotta pipe and should be driven so that when the first joint of farm tile is placed on top of it the tile will be flush with the end of the terra-cotta pipe. The remaining stakes should be driven down to the right level by using the straightedge as previously described. It has been found that farm tile may be laid more accurately and more rapidly if it is placed on boards in the bottom of the ditches. Consequently, after all stakes in each line have been driven to the right level, 1 by 4 boards 12 feet long should be placed edgewise, extending down the center of the ditches and toe-nailed on one side of the flat surface of the stakes flush with the top. After the boards have been nailed on, cinders, gravel, or other porous material should be filled back in the ditches even with the top edge of the boards. Beginning at the ends of the terra-cotta pipes, the farm draintile should be laid on the top edge of the boards at the bottom of the ditches, and as each joint is laid some earth or cinders should be thrown in and packed on each side of the pipe to hold it in position. A space of about one-fourth inch should be left between the ends of the pipes as they are laid, and the open joints should be covered with strips of tar paper lapped around the top and sides of the pipes as shown in Plate J. As these tar-paper collars are placed, some cinders should be packed in on either side to hold them in position. The tar-paper strips are usually cut 10 inches long and 6 inches wide. It is best not to fill the trench above the line of pipe until after all the tile in each line is laid. After the ditches have been filled, the earth should be well rounded up above the surface of the ground to allow for settling. If this is not done there will be sinks along the lines of the trenches after the earth has settled, and these will collect surface water and interfere with the working of the tile.

METHOD OF LAYING TILE IN SLOPING GROUND

Where the tile must be laid on a hillside or sloping ground it is necessary that the lines be placed at different levels. Plate I and Plate C show arrangement for distributing boxes and lines. From the points where the terra-cotta lines end it is necessary that the ditches for draintile be dug along the side of the hill or slope so that the bottoms will have the required fall of one-half inch in 12 feet and still be practically 17 inches in depth throughout. Before digging it is best to lay out and stake the grade of the draintile ditches on the surface of the ground. This can be done by using the straightedge and level, except that for this purpose, it is better

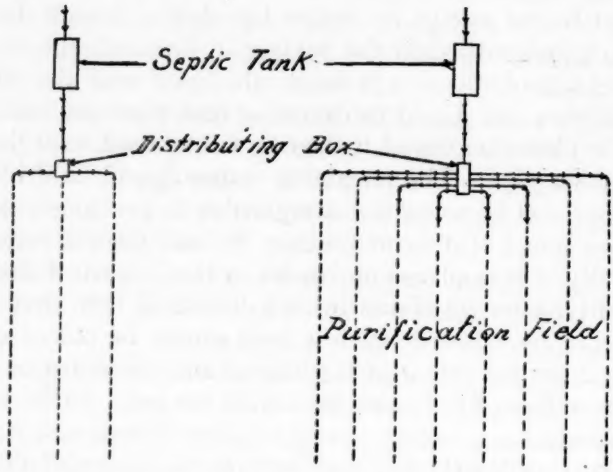


Fig. 1 Fig. 2

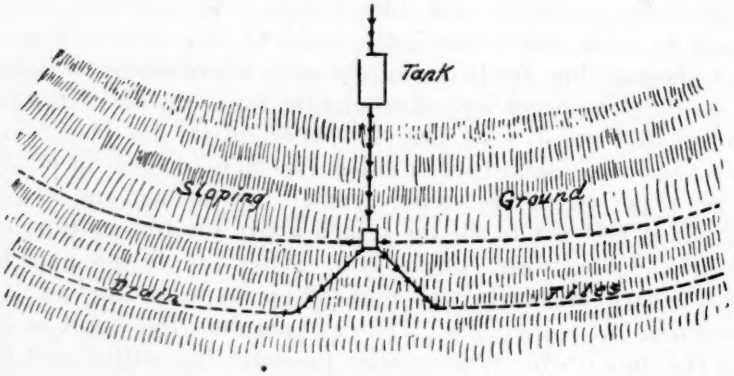


Fig. 3

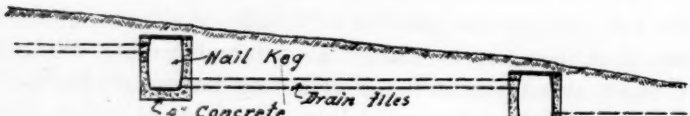


Fig. 4

Arrangements of Drain Tile.

A. WAGNER.

PLATE -I-

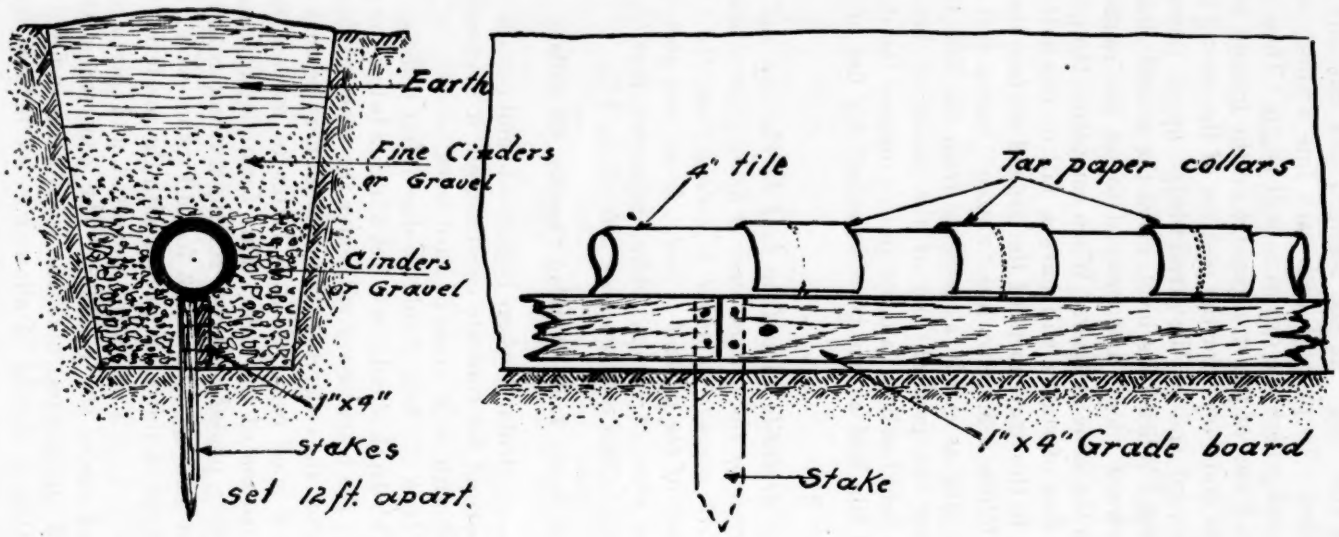
to nail some short upright strips at each end of the straightedge for "legs," having the "leg" at the forward end one-half inch longer than the other. To proceed with each line a stake should be driven at the point where the draintile will begin. Then place the "leg" at the back end of the straightedge on the ground by the side of the first stake and "try" for the position of the second stake, by moving the forward end of the straightedge up or down the slope until it is level. When it is level, drive the second stake by the side of the forward "leg" and proceed to set the remaining stakes in the line in the same manner. When completed the ground surface along this line of stakes will have a fall of one-half inch in 12 feet. Owing to the unevenness of the ground surface the line of the stakes may follow a more or less "zigzag" course and if so the ditch should be dug as evenly as possible from the first to the last stake, following the general line of the stakes in between. After the drainage field has been laid out in this manner the ditches should be dug and tile laid as has been described for flat or level ground.

NOTE: *Remember draintile should be laid in the top soil just deep enough to permit of the ground over it being plowed without striking the tile. An average of about 12 inches from the top of the tile to the surface of the ground is best. In no case should the tile be buried more than 16 inches. Also, whenever possible, the drainage field should be laid on the sunny side of the hill.*

The Brick-Wall Septic Tank—Working Capacity 450 Gallons

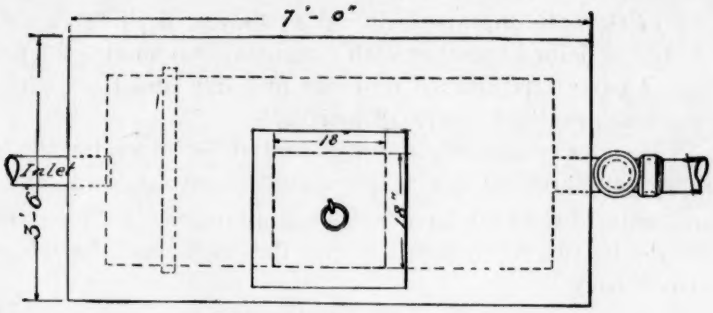
In some instances, particularly where both inside and outside wood forms would be required for concrete construction, it is cheaper to build the septic tank with walls made of hard brick.

To build a brick tank the hole should be dug 7 feet 6 inches long and 4 feet wide. The depth should be 4 feet 6 inches below the point where the bottom of the house sewer will enter the tank. When the excavation is completed the concrete bottom should next be made, and in order to insure a good even job it is better to use an outside wood form in the bottom of the hole. This form should be made of boards 6 inches wide, placed edgewise, making a frame with inside dimensions of 7 feet 4 inches long and 3 feet 10 inches wide. This should be firmly placed on the earth bottom with the top level. The concrete should be a 1:2:4 mixture, measured and prepared as previously described under the heading "The concrete mixture." It should be poured and tamped until the wood form is filled even with the top and then it should be allowed to set before starting to build the walls. As soon as the bottom has been finished the concrete slab baffles should be poured in a separate wood form

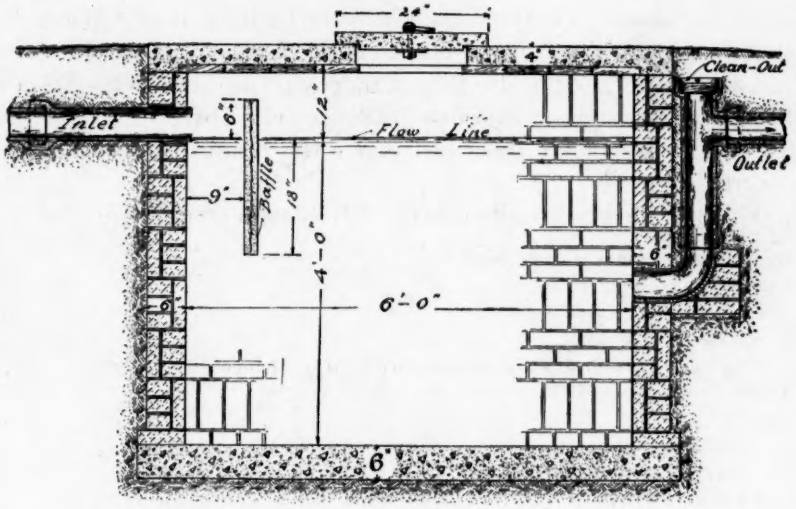


Method of laying Drain Tiles.

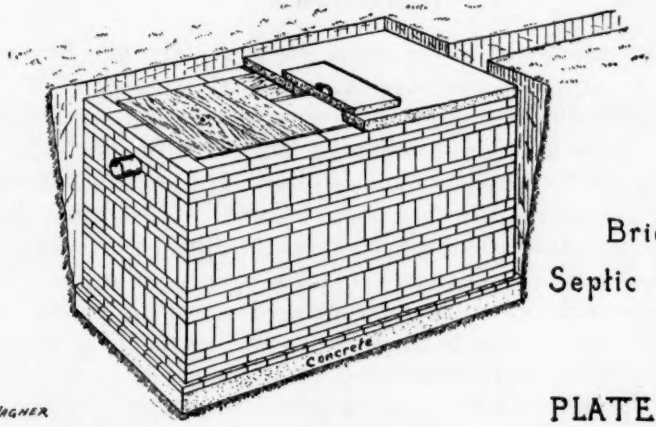
PLATE -J-



Top View



Section.



Brick
Septic Tank

A. WAGNER

PLATE -K-

previously described. After the concrete bottom has become firm, the brick walls may be built up as shown in Plate K. The bricks should be joined together with cement mortar made of 1 part cement and 2 parts sand, mixed together first dry and then with sufficient water to provide a good stiff mortar.

The parts comprising the inlet and outlet pipes for the brick wall septic tank are the same as described for concrete tank, and when the end walls of the tank have been built up to the right levels these pipes should be placed in position and the walls completed around and above them.

When the side walls at the inlet end of the tank are completed to the level of 2 feet 6 inches above the floor, the baffle slab should be placed as shown in Plate K and the walls built up around the ends of the slab to hold it firmly in position. If clean-out drain is used, the cast-iron parts should also be put together and installed. After the brick walls have been completed, the concrete cover should be made exactly as previously described under the heading "The baffle and concrete cover."

To build the brick-wall tank, the following materials are necessary:

Brick: 1,000 common hard brick.
Concrete and mortar:
11 bags Portland cement.
1 cubic yard sand.
⅔ cubic yard crushed stone or gravel up to ¾-inch size.
Lumber: 50 square feet tongue and grooved boards.
Fittings:
1 4-inch terra-cotta elbow.
1 4-inch terra-cotta T.
1 joint terra-cotta pipe for inlet (same size as house sewer).
1 ring bolt for manhole cover.

Final Inspection

After the completion of the entire disposal plant, and before it is used, a final inspection should be made and all parts tested for leaks, etc. The tank should be filled with water until it runs over into the draintile system, and if a distributing box is used it should be noted whether or not the overflow water is distributed more or less equally to the several outlets from the box. In order to determine whether or not the septic tank leaks, it is best that it be filled with water in the afternoon or evening and allowed to stand over night and next morning the level of the water should be marked with a line on the wall of the tank. It should then be allowed to stand for 24 hours, and if the water level drops more than one-half inch during the 24 hours, it indicates that the tank leaks and it should be emptied and the leaky place or places found and repaired with cement immediately. If the leaky places can not be found, it is best to plaster the whole inside

surface of the septic tank with cement mortar to insure that the leaks are repaired. If it is found that the tank does not leak, it may be put into operation immediately, first adding about six yeast cakes dissolved in water or about one-half bushel of well rotted horse manure, free from straw, cornstalks, etc. Either of these will aid in starting the fermentation or septic action in the tank.

Care and Operation of Sewage-Disposal Plants

The experience of public-health workers has shown that there is probably no piece of property which is more neglected than the sewage-disposal plant. All other properties are generally looked after and repaired from time to time, but the sewage-disposal plant is installed and then usually forgotten until continued neglect causes it to "go bad" all at once, and then the property owner finds that he must spend money to replace completely clogged drainage tile or other parts, which expense might have been prevented by a little inspection and attention from time to time.

The proper care of the septic-tank disposal plant must begin with the habits of the family in the use of the plumbing fixtures in the home. Only standard toilet paper should be used, and such things as newspaper, sticks, rags, rubbish, garbage, etc., should never be thrown into the toilet, as these things will not disintegrate in the tank, but will remain to either stop up the pipes or to cause the tank to fill up with solid matter much more rapidly than it otherwise would.

It has been explained that the septic tank will have to be cleaned out from time to time. How often it will require cleaning depends upon the care of the property and the quantity of solids going into the tank. Some tanks need cleaning out every year; others will work for two or three years without being cleaned. There is only one way to tell, and that is to look. The manhole cover should be removed at least once each year and the condition of the contents of the tank learned. By using a short pole and moving it up and down from side to side, it is possible to tell about how much deposit there is in the bottom of the tank and how much scum there is on top. Some tanks accumulate scum more rapidly than sludge. In others the deposit of sludge is greater than the scum. In either event, when both scum and sludge have accumulated to a thickness of 10 or 12 inches, or where both classes of solids together have accumulated to a thickness of 2 feet or more, the tank should be cleaned.

If a clean-out drain has been installed as previously described and recommended, the cleaning will be easy. The 6-inch terra-cotta drain pipe should lead to a shallow pit in the ground, located more than 100 feet away and down the slope from the well or spring. The pit

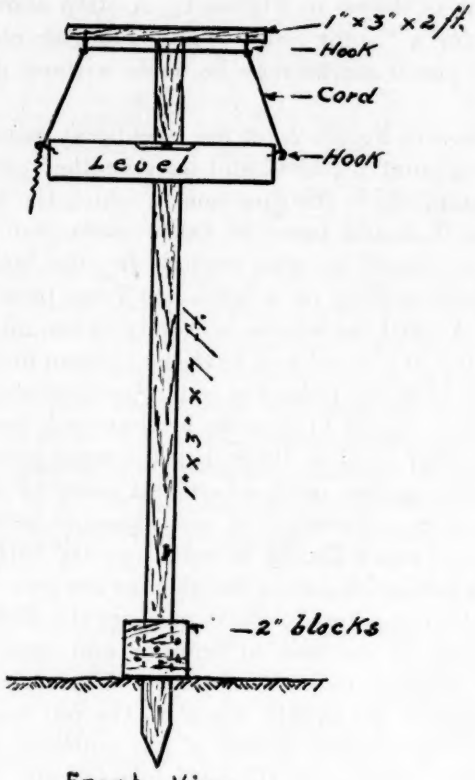
should be about 2 to 2½ feet deep and should be large enough to hold all the contents of the septic tank and to be covered over the top with boards and earth. The contents of the tank may be drawn off into this pit and there allowed to leach and dry out until the next cleaning is necessary. Just before cleaning the second time the pit should be opened and the dried-out sludge from the previous cleaning may be hauled away and disposed of as manure. The pit should also be put in condition for the second cleaning and probably new boards will be required to support the earth cover.

Where a clean-out drain has not been provided, cleaning is a more difficult matter. In such cases the contents of the tank must either be pumped or bailed out into a pit such as described for sludge drain. Before the tank is cleaned, the contents should be thoroughly stirred so as to get the solids in solution. Where there is no sludge drain the unpleasant task of cleaning may be lessened by the use of chemicals. Fifty pounds of caustic soda dissolved in water and poured into the tank 24 hours before the time of cleaning will liquefy the contents (of 400 gallons capacity) and destroy the unpleasant odor to a considerable extent. After the tank has been cleaned out it should be allowed to fill up again, and if caustic soda has been used, yeast cakes dissolved in water or about a half-bushel of well-rotted manure should be added as was done at first.

Where a distributing box is used in the tile drainage system it has been explained that this may be also be used as a diverting box. As shown in the illustration Plate H, a stop plank may be placed over one or all of the openings on one side of the box so as to cause all the sewage to go to the openings on the other side. By changing the stop plank the condition is reversed. In this manner part of the purification field may be allowed to rest while the other is in use. It has been found that this way of using the purification field will prolong the life of the system.

Simple Method of Determining Difference in Elevation by Means of a Carpenter's Level

In choosing locations for sewage disposal plants it is often necessary to know absolutely the difference in elevations between various points. A simple method of using a carpenter's level is illustrated in Plate L. For holding the level, a stake 7 feet long is required, with a short strip about 2 feet long nailed across the top as shown in Figure 1. The level is suspended from this strip by a cord attached to hooks in the ends of the level and run through hooks screwed in the underside of the cross piece near each end. This makes it possible to adjust the level for making sights after the stake has been driven in the ground. The stake should also have two blocks bolted on to the side about 1 foot from the bottom so that it may be



Front View

Side View

Fig. 1

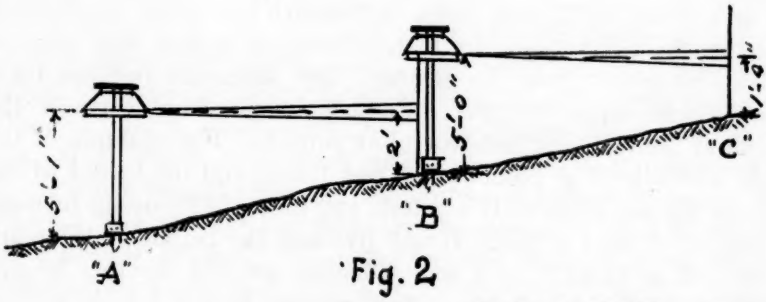


Fig. 2

PLATE -L-

forced into the ground by driving on top of the blocks instead of on top of the stake. This is shown in Figure 1. A strip about 6 feet long is also needed for a "sight rod." This should be clean, dressed lumber on which pencil marks may be made without difficulty.

To run the levels as shown in Figure 2, set the level up at point A, which should be the lowest point required, and have another person hold the rod at another point, B, in the direction in which the level line is to be run. Point B should never be taken more than 125 feet from point A and it should be near enough for the bottom of the rod to be seen when sighting on a level line from point A. Adjust the level at point A until the bubble is exactly in the middle and then sight along the top at the rod and have the rodman make a pencil mark where the line of sight strikes the rod. Since carpenters' levels are not always exact, it is best to turn the level around, reversing the ends, and take another sight at the rod in the same position and have the rodman make another mark where this point of sight strikes the rod. There may be a difference of several inches between the two marks, and, if so, a mark should be made exactly halfway between the two, and this last mark should be taken as the true level line along the top of level from point A. Next measure the distance from the ground to the top of the level at point A and write the measurement down on a notebook or piece of paper. Then measure the height from the ground to the middle mark on the rod held at point B and write this measurement down in the notebook in a different place on the sheet. Next move the level forward and set it up at the exact point where the rod was placed at point B. Then move the rod forward to the third point, C. Take the two sights with the level and rod as previously described. Then measure again the height from the ground to the top of the level and write the figures down underneath the other similar measurement. Also measure again the height from the ground to the middle mark on the rod and write the figures down underneath the other similar rod measurement. Next add the two columns of figures and subtract the lesser amount from the greater. The difference between these two amounts represents the difference in elevation between the ground at point A and the ground at point C. For example, if the height of the level at point A is 5 feet 1 inch and the height of the mark on the rod at point B is 2 feet, and then after moving forward the height of level at point B is 5 feet and the height of the mark on the rod at point C is 1 foot 4 inches, we add the two heights of the level 5 feet 1 inch plus 5 feet, making 10 feet 1 inch, and we add the two rod measurements, 2 feet plus 1 foot 4 inches, making 3 feet 4 inches, then subtract 3 feet 4 inches from 10 feet 1 inch,

which is the difference in elevation between the ground at point A and point C.

Heights of level	*Rod readings*
5 feet 1 inch	2 feet 0 inch
5 feet 0 inch	1 foot 4 inch
10 feet 1 inch	3 feet 4 inch

10 feet 1 inch
3 feet 4 inch

6 feet 9 inches=difference in elevation

If more than two sights are required to run the level line, the measurements should be kept for each sight as described. The several heights of the level should be kept in one column and the same number of rod readings should be kept in the other column. After all sights have been taken, each column of figures should be added and the total of the rod measurements subtracted from the total height of level measurements. The result will represent the difference in elevation between the ground level at the starting point A and the ground level at the final point.

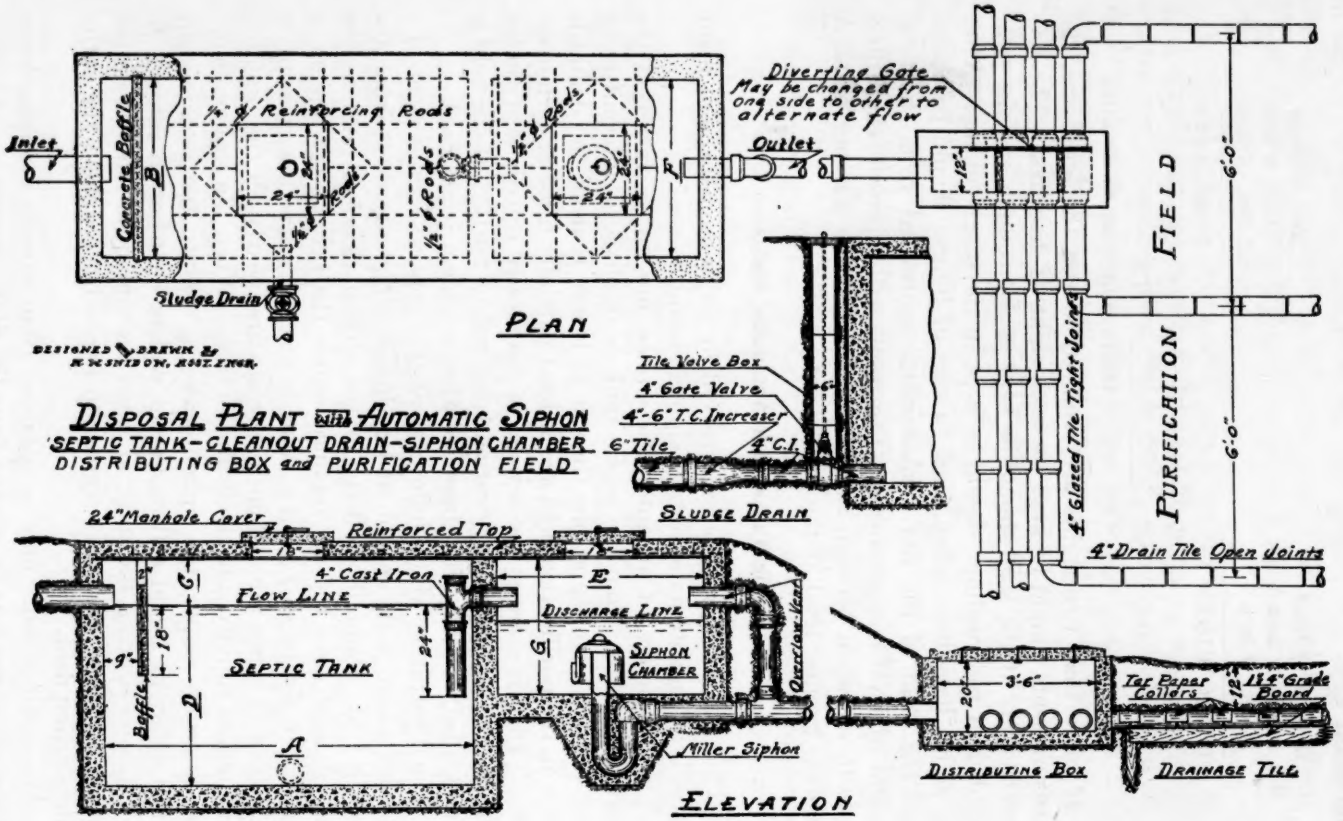
Septic Tanks with Automatic Siphon

When the number of persons served by the sewage-disposal plant exceeds 20 an automatic sewage siphon should be used.

The advantage of an automatic siphon lies in the fact that the sewage overflow from the septic tank is discharged intermittently and in such quantity at one time as to insure that all the draintile lines in the purification field are at least partially filled at each overflow. In this manner the sewage is practically equally distributed throughout the entire purification field, and no portion of the field is overloaded, as most often happens when a siphon is not used.

The illustration which follows shows the general arrangement of a sewage plant with an automatic siphon. The overflow from the septic tank gradually collects in the siphon chamber, and as the liquid level rises the air retained under the bell of the siphon is gradually compressed until a point is reached where the pressure is sufficient to cause the siphon to operate and nearly all the liquid is discharged rapidly into the draintile lines. When the siphon chamber is nearly empty, the siphon ceases to operate and remains idle until sufficient liquid collects in the siphon chamber to cause it to act again. During the interval when the siphon is idle, the liquid in the tile lines gradually seeps into the soil throughout the entire purification field.

Automatic siphons may be obtained from various manufacturers, whose addresses may be secured from the State department of health. Ordinarily the small 4-inch and 5-inch siphons cost around $25 to


Inlet
Concrete Baffle
½" ø Reinforcing Rods
Diverting Gate
May be changed from one side to other to alternate flow
Outlet
Sludge Drain
PLAN
DESIGNED & DRAWN BY
K. W. SNIDOW, ASST. ENGR.
DISPOSAL PLANT with AUTOMATIC SIPHON
SEPTIC TANK - CLEANOUT DRAIN - SIPHON CHAMBER
DISTRIBUTING BOX and PURIFICATION FIELD
Tile Valve Box
4" Gate Valve
4"-6" T.C. Increaser
6" Tile
4" C.I.
Sludge Drain
FIELD
PURIFICATION
4" Glazed Tile Tight Joints
4" Drain Tile Open Joints
6'-0"
24" Manhole Cover
Reinforced Top
4" Cast Iron
Flow Line
Discharge Line
Siphon Chamber
Septic Tank
Baffle
Miller Siphon
Distributing Box
Drainage Tile
Tar Paper Collars
ELEVATION

$35. Current prices and instructions for installing may be obtained by writing direct to the manufacturer.

Specifications for Different Sizes of Sewage Disposal Plants

The tables which follow give specifications for various sizes of sewage-disposal plants, with and without siphons, to accommodate different numbers of persons served. Particular attention is called to the table showing sizes of septic tanks and siphon tanks for schools, etc., where the sanitary fixtures are used only during the day. The sizes given in the table are for schools where there are only the usual flush toilet fixtures. For schools in which there are also shower baths, the capacity of the septic tanks and the amounts of drain tile should be doubled in order to take care of the extra water from the shower-baths will be used, the size of the septic tank and quantity of drain tile should be as designated in the table for a school of 400 pupils.

Specifications for plants with automatic siphon

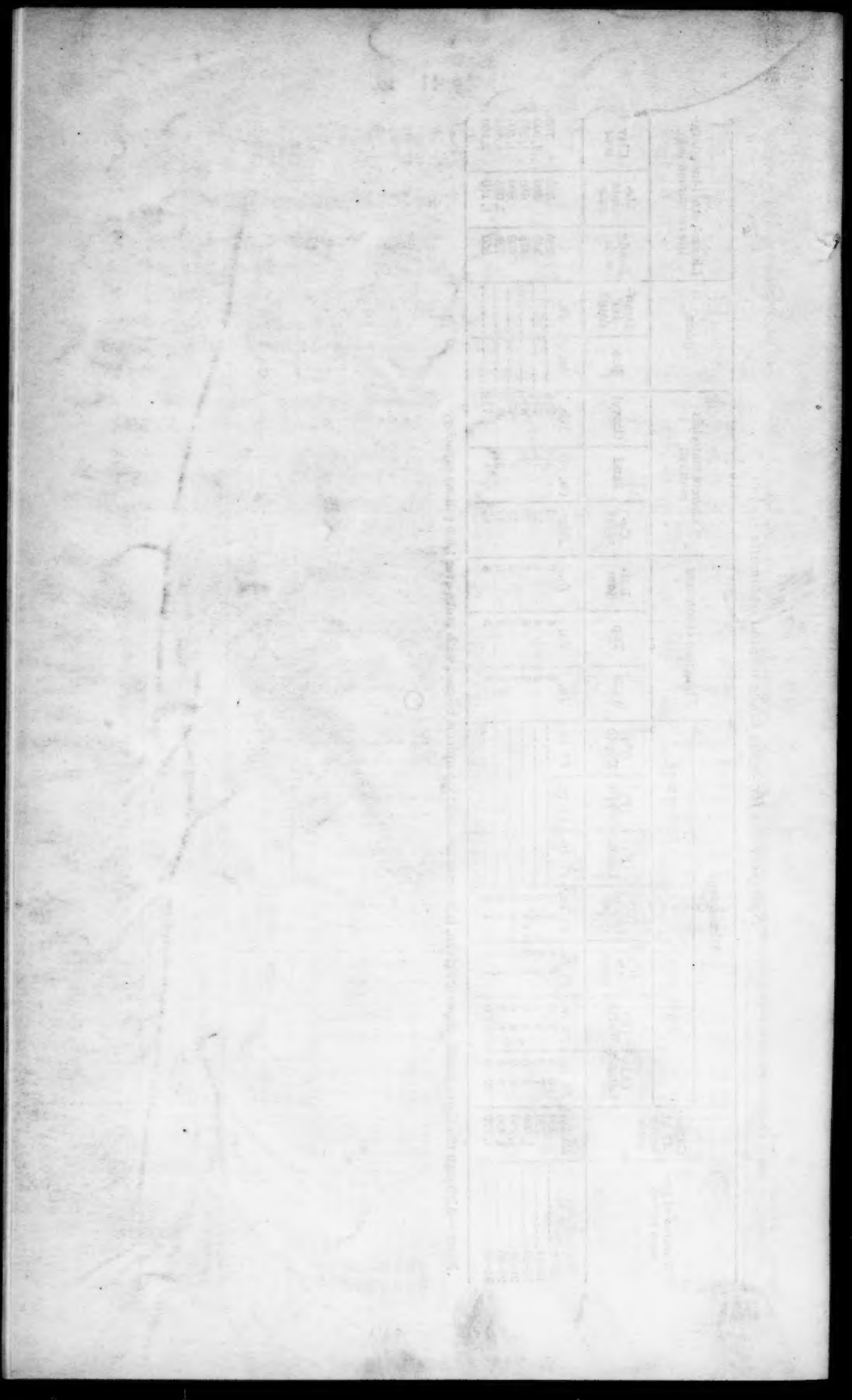
Number of persons served	Capacity of septic tank	Dimensions: Septic tank (A) Length	(B) Width	(C) Air space	(D) Liquid depth	Dimensions: Siphon tank (E) Length	(F) Width	(G) Depth	Thickness of concrete: Walls	Top	Bottom	Concrete materials required: Cement	Sand	Gravel	Siphon: Size	Drawing depth	Linear feet of 4-inch drain-tile recommended: Sandy soils	Medium soils	Clay soils
	Gallons	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*In.*	*In.*	*In.*	*Bags*	*Cu. yds.*	*Yds.*	*In.*	*In.*			
5– 9	450	6 0	2 6	1 0	4 0	3 0	2 6	3 0	6	4	6	22	2	3½	4	17	200	350	700
10–14	720	7 0	3 6	1 0	4 0	3 6	3 6	3 0	6	4	6	29	2¾	4½	4	17	340	500	1,000
15–20	1,000	8 0	4 0	1 0	4 0	4 0	4 0	3 0	6	4	6	34	3¼	5¼	4	17	475	650	1,250
21–25	1,250	9 0	4 6	1 0	4 3	4 6	4 6	3 0	7	5	6	45	4	7¼	4	17	600	800	1,500
26–30	1,480	9 6	4 8	1 3	4 6	4 8	4 8	3 6	8	5	6	56	5	9	5	23	725	1,025	1,800
31–35	1,720	10 0	5 0	1 3	4 8	5 0	5 0	3 6	8	5	6	62	5½	10	5	23	850	1,150	2,100
36–40	1,950	10 6	5 3	1 3	4 9	5 3	5 3	3 6	9	5	6	73	6¼	12	5	23	975	1,300	2,400
41–45	2,175	11 0	5 6	1 3	4 10	5 6	5 6	3 6	9	5	6	77	6½	12½	5	23	1,100	1,450	2,700
46–50	2,400	11 6	5 9	1 3	5 0	5 9	5 9	3 6	9	5	6	83	7	13½	5	23	1,200	1,600	3,000

For schools, etc., requiring only 8-hour day service

Number of persons served	Capacity of septic tank	Dimensions: Septic tank (A) Length	(B) Width	(C) Air space	(D) Liquid depth	Dimensions: Siphon tank (E) Length	(F) Width	(G) Depth	Thickness of concrete: Walls	Top	Bottom	Concrete materials required: Cement	Sand	Gravel	Siphon: Size	Drawing depth	Linear feet of 4-inch drain-tile recommended: Sandy soils	Medium soils	Clay soils
	Gallons	*Ft. in.*	*Ft. in*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*In.*	*In.*	*In.*	*Bags*	*Cu. yds.*	*Yds.*	*In.*	*In.*			
200	2,000	11 0	5 0	1 3	5 0	5 0	5 0	3 6	9	5	6	74	6½	12	5	23	800	1,200	2,000
300	3,000	13 6	6 0	1 3	5 0	6 0	6 0	3 6	9	5	6	93	8	15	5	23	1,200	1,800	3,000
400	4,000	15 6	7 0	1 4	5 0	7 0	7 0	3 6	9	5	6	112	9½	18	5	23	1,600	2,400	-------
500	5,000	18 0	7 6	1 5	5 0	7 6	7 6	3 6	10	5	6	140	12	23	5	23	2,000	3,000	-------
600	6,000	20 0	8 0	1 6	5 0	8 0	8 0	3 6	10	5	6	156	13½	25½	5	23	2,400	3,600	-------

NOTE.—The above specifications are for use with schools without shower baths. If shower baths are used, sewage plant with specifications for double the number of persons should be adopted.

Specifications for septic tanks without automatic siphon

Number of persons served	Capacity of septic tank	Dimensions							Thickness of concrete			Concrete materials required			Siphon		Linear feet of 4-inch drain-tile recommended		
		Septic tank				Siphon tank													
		(A) Length	(B) Width	(C) Air space	(D) Liquid depth	(E) Length	(F) Width	(G) Depth	Walls	Top	Bottom	Cement	Sand	Gravel	Size	Drawing depth	Sandy soils	Medium soils	Clay soils
	Gallons	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*In.*	*In.*	*In.*	*Bags*	*Cu. yds.*	*Yds.*	*In.*	*In.*			
5– 9	450	6 0	2 6	1 0	4 0				6	4	6	16	1½	2½			200	350	700
10–14	720	7 0	3 6	1 0	4 0				6	4	6	21	1¾	3½			340	500	1,000
15–20	1,000	8 0	4 0	1 0	4 0				6	4	6	26	2½	4¼			475	650	1,250
21–25	1,250	9 0	4 6	1 0	4 3				7	5	6	35	3	5½			600	800	1,500
26–30	1,480	9 6	4 8	1 3	4 6				8	5	6	42	3½	7			725	1,025	1,800
31–35	1,720	10 0	5 0	1 3	4 8				8	5	6	46	4	7½			850	1,150	2,100

NOTE.—Although the above specifications are given, it is recommended that siphons be used with tanks over 1,000 gallons capacity.